advisable to install a water-softening plant, the practice is sometimes followed of making additions to the contents of the boiler for the purpose of causing the scale-forming substances to separate as a soft sludge capable of being periodically expelled by blowing down. These so-called boiler fluids or anti-incrustation mixtures are of various compositions, sometimes consisting of a weak aqueous solution of soda carbonate or caustic soda alone, but more frequently containing, in addition, organic matter of a mucilaginous character (Irish moss, agar, starch, or gum), tannins, and other vegetable products belonging to the group of colloids. For small boiler installations and in special circumstances such compositions have their uses, but obviously they should be employed with caution, for reasons alike of safety and of economy.

Corrosion of Metals.—The destructive effect of certain waters on steam boilers has already been referred to and illustrates a subject of enormous importance to the engineer, namely the liability of metals in general to enter into chemical changes while in use, giving rise to what is called corrosion.

In the rusting of structures exposed to moist air, the pitting of boilers, the giving out of steam-pipes, the erosion of turbine blades, and the failure of condenser tubes, it meets him on every side. In some cases the damage may be accidental, such as happens when an acid mine-water or a pickling effluent is admitted to a river or canal and is used for steam-raising, but for the most part it is the result of having to bring metals into contact with a system containing water, oxygen, and carbonic acid, reinforced in some cases by chlorides in solution, and these must be looked upon as more or less normal constituents of natural waters. The choice of metals for construction must be made with a number of considerations in view, of which chemical inertness is only one, and it frequently happens that mechanical qualities and cost decide the use in certain circumstances of a metal the composition of which renders it liable to considerable corrosion, in preference to one that is more stable.

Erratic Appearance of Corrosion.—One of the most puzzling features of corrosion as ordinarily observed is its erratic character, giving rise

to a widespread belief either that it is a matter of chance or is to be ascribed to concealed defects in the metal for which the manufacturer is accountable. It is true that such defects sometimes exist, in the form of dissolved impurities, slag inclusions, imperfect mixing, and unsuitable crystalline structure, and that these may originate or accelerate wastage of the metal when in use; but it must be borne in mind that the purest commercial metals are not immune, and that care must be exercised in the selection of steels, brasses, bronzes, and other metallic mixtures to obtain what is best fitted to withstand the particular conditions they are to be subject to. As a matter of fact the erratic appearance of corrosion is due less to variations in the quality of the particular metal than to the number and variability of the chemical forces brought to bear upon it when in use. It may happen that a temporary circumstance of merely chance occurrence determines for a piece of metal whether its career is to be long or short, and the relative preponderance of protective and destructive forces